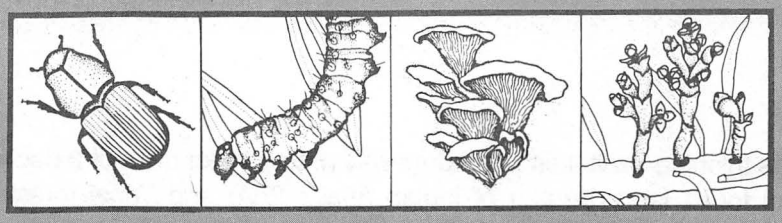
Forest Pest Management



Report 89-6

3450
June 1988

AN EVALUATION OF THE EFFECTIVENESS OF DWARF MISTLETOE SUPPRESSION IN UNEVENAGED STANDS ON THE FLATHEAD INDIAN RESERVATION

by

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ABSTRACT

Dwarf mistletoe is a serious problem on the Flathead Indian Reservation. Since the early 1970's, a procedure called thinning-sanitation has been applied to lightly infested stands. Evaluation of this procedure indicated that average dwarf mistletoe infection levels now range from 7 to 50 percent in larch and Douglas-fir treated 10 years ago. A second thinning, designed to remove the remaining infections, would leave an additional 30 percent of residuals infected. It is concluded that the thinning-sanitation procedure has not been effective in controlling dwarf mistletoe, even in what appear to be lightly infested stands.

INTRODUCTION

Timber management on the Flathead Indian Reservation calls for the use of unevenaged management whenever possible. Permanent plot growth data show that one of every four Douglas-fir, western larch, and/or lodgepole pine host trees is infected with dwarf mistletoe (*Arceuthobium* spp.). Management of this forest disease has generally proven difficult under unevenaged silviculture. Infected overstory trees produce dwarf mistletoe seeds which readily infect understory trees, thus encouraging the spread and intensification of *Arceuthobium* in infested stands. Furthermore, there is less opportunity to eliminate infected individuals at the time of regeneration, as is the case with evenaged management.

In response to the Reservation's desire to limit clearcutting, a procedure was developed in the 1970's that addressed the unevenaged management objective. The intent was to attempt the use of unevenaged management in lightly infested stands - those with up to one-third of the stems infected. The procedure, called thinning-sanitation, involved the selective logging of all visibly infected merchantable trees (those above 9 inches d.b.h.) at the first stand entry. The follow-up precommercial thinning removed infected individuals up to 7 inches d.b.h., and on up to merchantable size if more than 50 percent of a tree's branches were infected. The procedure was later adjusted to remove all infected trees up to 9 inches d.b.h. during the precommercial thinning (second entry). The removal of all visibly infected trees of all age classes should, therefore, be accomplished following this procedure in lightly infested stands. Severely infested stands would continue to be regenerated via clearcutting or seed tree cutting, both evenaged techniques.

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The thinning-sanitation procedure was practiced for most of 2 decades throughout the Reservation's commercial forest land. Bureau of Indian Affairs (BIA) and Tribal foresters have recently made some preliminary observations in stands treated 10 years ago using the aforementioned thinning-sanitation procedure. Considerable infection was found in these stands, previously thought rid of dwarf mistletoe infection due to stand treatment. Consequently, a biological evaluation was requested and is presented in two parts.

OBJECTIVE 1

To determine the effectiveness of the thinning-sanitation procedure in controlling dwarf mistletoe in lightly infested stands on the Flathead Indian Reservation.

METHODS

In late November 1987, disease information was collected from six stands within three different timber sales, all receiving the thinning-sanitation treatment within the past 8-10 years (Table 1). For each area, the goal had been to remove *all* trees infected with dwarf mistletoe during the thinning-sanitation procedure. Data were collected on 1/20-acre plots established 1 chain apart along transects within sale boundaries. Data included tree species, diameter at breast height, and dwarf mistletoe rating (Hawksworth, 1977) for all plot trees 1-inch d.b.h. and larger. Stand summaries were obtained using the R-1 Forest Insect and Disease Damage Survey System (INDIDS) (Bousfield, 1980). All stands were composed of mixed species, with varying amounts of Douglas-fir, western larch, ponderosa pine, lodgepole pine, and grand fir.

Table 1--Timber sale areas surveyed for dwarf mistletoe infection on the Flathead Indian Reservation.

Timber Sale	No. Areas Surveyed	Total No. Plots	Years Treated
Garden Creek	3	40	1979-80
Irvine Flats	2	25	1977-79
Hot Springs	1	20	1976-79

RESULTS AND DISCUSSION

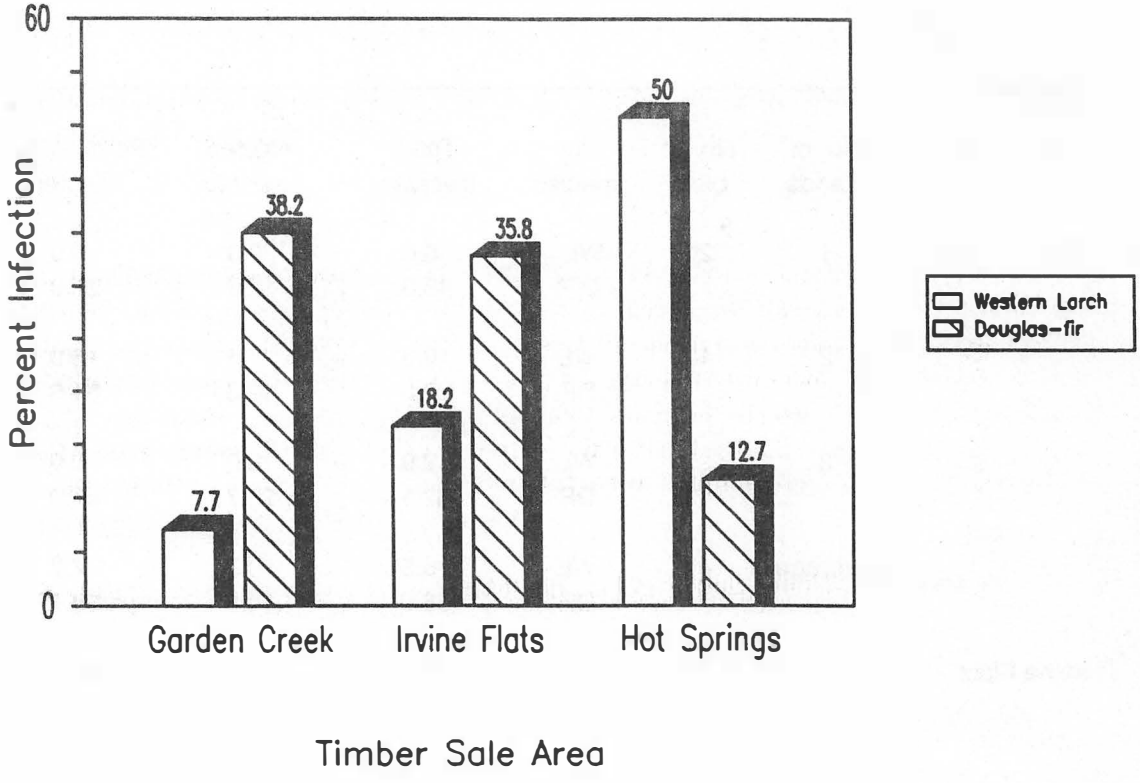
Survey data supported preliminary observations that a significant number of infected trees remained following thinning-sanitation efforts (Table 2, Figure 1). Average percentage of western larch infected in the three sale areas surveyed was 7.7, 18.2, and 50.0, and 38.2, 35.8, and 12.7 in Douglas-fir, showing tremendous variation between timber sale areas. Infection levels also varied considerably for both tree species within sale areas. For example, the average amount of larch infected in the Garden Creek Timber Sale was 7.7 percent. However, two of three stands surveyed had no visible larch mistletoe, and a third had 14 percent infection. Douglas-fir infection levels ranged from 28 to 62 percent in the same timber sale.

Table 2--Dwarf mistletoe infection on Douglas-fir and western larch in Flathead Indian Reservation timber sale areas 8-10 years after thinning-sanitation.

Timber sale area	No. of stands	No. of plots	Tree species	Total trees/ac	Infected trees/ac	Percentage infected	DMR Range	DMR X
Garden Creek	1	20	WL[1]	5.0	0.0	0.0	--	0.0
			DF[2]	43.0	12.0	27.9	0-3	1.5
	2	13	WL	10.8	1.5	13.9	3	3.0
			DF	20.0	12.3	61.5	0-5	3.5
	3	7	WL	2.9	0.0	0.0	--	0.0
			DF	57.1	25.7	45.0	0-3	1.5
	Average	40	WL	6.5	0.5	**7.7**	3	1.0
			DF	38.0	14.5	**38.2**	0-5	2.2
Irvine Flats	1	10	WL	30.0	8.0	26.6	0-4	2.3
			DF	78.0	34.0	43.6	0-6	1.8
	2	15	WL	9.3	0.0	0.0	--	0.0
			DF	37.3	9.3	24.9	0-6	3.1
	Average	25	WL	17.6	3.2	**18.2**	0-4	0.9
			DF	53.6	19.2	**35.8**	0-6	2.6
Hot Springs	1	20	WL	34.0	17.0	**50.0**	0-6	3.4
			DF	71.0	9.0	**12.7**	0-4	2.2

[1] WL = western larch
[2] DF = Douglas-fir

Figure 1--Dwarf mistletoe infection on Douglas-fir and western larch in Flathead Indian Reservation timber sale areas 8-10 years after thinning-sanitation.



Dwarf mistletoe ratings (DMR) were typically low, between 1-3 on the 6-class scale, although heavily-infected individuals were tallied at several plot locations. All diameter classes of trees were infected as well (Table 3). Because of variation in sample size, no significant relationships could be made concerning infection frequency by diameter class following treatment. Therefore, we can only assume that dwarf mistletoe infection was uniformly difficult to diagnose throughout the range of tree diameter classes prior to thinning-sanitation, resulting in unacceptable post-treatment infection levels.

Table 3--Ratio and percentage of western larch and Douglas-fir infected with dwarf mistletoe by diameter class after thinning-sanitation.

Timber Sale	Tree Species	No. of Plots	Diameter Class 0-4.9 T/A[1] (%)	5-8.9 T/A (%)	9-11.9 T/A (%)	12+ T/A (%)
Garden Creek	WL	40	.5/.5 (100)	0/3.5 (0)	0/1.5 (0)	0/1.0 (0)
	DF		2/5.5 (36)	2/7.5 (27)	8/20.5 (39)	2.5/4.5 (56)
Irvine Flats	WL	25	0/.8 (0)	1.6/8.0 (20)	.8/5.6 (14)	.8/3.2 (25)
	DF		.8/2.4 (33)	10.4/31.2 (33)	7.2/13.6 (53)	.8/6.4 (13)
Hot Springs	WL	20	4/6.0 (67)	9/19.0 (47)	2/7.0 (29)	2/2.0 (100)
	DF		0/7.0 (0)	4/34.0 (12)	3/24.0 (13)	2/6.0 (33)

[1] T/A represents infected/total trees per acre in that diameter class.

Without further treatment, the prognosis for the infested stands surveyed in this evaluation is not promising. A number of alternative treatments are available, depending on stand infection levels, structure, age, composition, etc. One of the alternatives proposed was the option of performing yet another thinning-sanitation treatment in stands treated 8-10 years previously. After initial thinning, 90 percent of all latent infections will appear within 5 years (Shea, 1964). A second treatment would identify and remove infected trees that escaped the first thinning. An evaluation was requested to study such an alternative, and is the subject of the next section of this report.

OBJECTIVE 2

To determine if a second series of thinning-sanitation cuts would reduce dwarf mistletoe in infested stands to acceptable management levels.

METHODS

To determine whether a second stand treatment would be successful, the number of infected trees that are overlooked during marking needs to be quantified. Essentially, the question to be answered is: how many symptomless trees are actually infected with dwarf mistletoe, inadvertently left to infect healthy residuals and perpetuate the disease?

A mixed stand with a component of approximately 50 percent Douglas-fir was chosen for the evaluation. The stand, located in the Garden Creek Timber Sale, had been selectively logged in 1980 to remove all merchantable infected trees in the overstory. Following in 1981, the stand was precommercially thinned to eliminate infected individuals in the understory. The study area was 2 acres in size, representing the general condition of the rest of the stand... although treated 7-8 years previously, mistletoe-broomed trees were prevalent in the overstory.

The evaluation was conducted in three steps during mid-August 1988. First, the stand was marked for logging at an "operational pace" by two BIA foresters. Both foresters were experienced in identifying dwarf mistletoe, and marked all visibly-infected trees accordingly. Unmarked, or "symptomless" trees were thought to be free of the parasite.

The second time through the study area, the two foresters and a Forest Service plant pathologist sequentially numbered and carefully re-examined every Douglas-fir in the stand. Binoculars were used during this step to confirm questionable mistletoe infections and to more closely view branches well above the ground. Infected trees were individually rated using Hawksworth's 6-class system. Diameter, crown ratio, and crown class were also tallied for each tree.

The third step in this evaluation involved validation of these ground-level observations. Symptomless trees were felled and inspected branch by branch for dwarf mistletoe infections. Any such infections were sampled and aged (Scharpf and Parmeter, 1966) to determine if the host tree had actually been infected and not removed during initial thinning-sanitation efforts 8 years previous.

RESULTS AND DISCUSSION

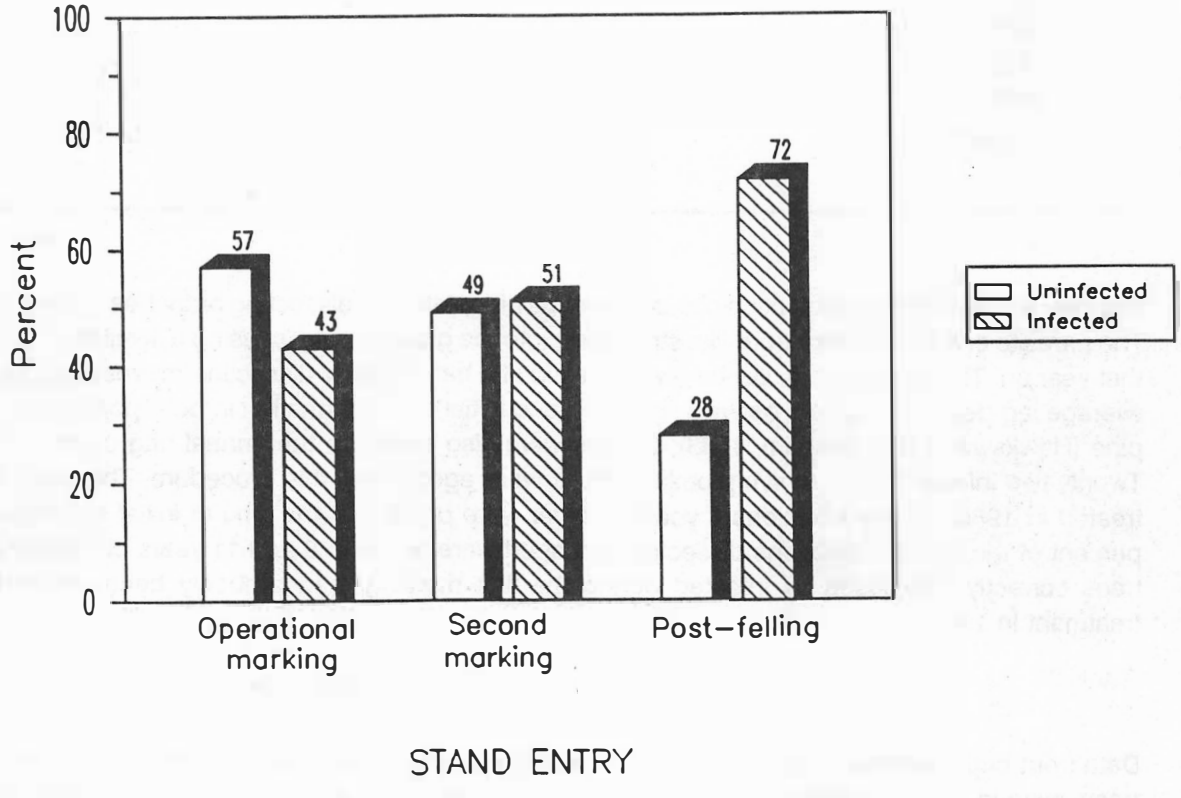
A total of 74 Douglas-fir trees were included in the evaluation (Table 4, Figure 2). The first marking identified 32 trees, or 43 percent of the stand infested 7-8 years after treatment. This information paralleled results from the first evaluation presented in this report. The second time through the stand, six more trees, or an additional 8 percent, were found to have infections. Thirty-six symptomless trees remained of the 74 in the study area. Those trees were felled, and upon examination, an additional 15 individuals (21 percent) were infected with *Arceuthobium douglasii*. Seventy-two percent of the stand was actually infested 7-8 years after thinning-sanitation, 30 percent more than first observed.

Table 4--Quantification of dwarf mistletoe infection in a Douglas-fir stand after a second thinning-sanitation treatment on the Flathead Indian Reservation, 1988.

	1st Marking	2nd Marking[1]	Post-Felling[2]	Totals
No. Sampled	74	42	36	74
No. Infected	32	6	15	53
Percent of Total Infected	43	8	21	72

[1]Trees found symptomless in the first marking were examined.
[2]Trees found symptomless in the second marking were examined.

Figure 2--Quantification of dwarf mistletoe infection in a Douglas-fir stand after second thinning-sanitation treatment on the Flathead Indian Reservation, 1988.



Individual dwarf mistletoe ratings were also underestimated (Table 5). Of the 15 trees discovered infected after felling, 10 received a rating of one, three were rated a two, and two trees were infected enough to earn a rating of three. The six trees which were misdiagnosed in the first marking were also felled for examination, to see how closely they were rated the second time through the stand. Of these, one tree maintained its original rating, while two increased by one DMR class, and three increased by two classes.

Table 5--Dwarf mistletoe ratings in infected Douglas-fir trees before and after felling on the Flathead Indian Reservation.

	Second Marking Infected	Post-Felling Infected
DMR > 0	1	0
DMR > 1	2	10
DMR > 2	3	3
DMR > 3	0	2
Total	6	15

The year a dwarf mistletoe infection occurred can be pinpointed by dissecting branches at the point of infection. The parasite embeds sinkers (root-like structures) into the growing twig, causing a swelling of annual rings from that year on. This swelling can be seen with the aid of a hand lens or dissecting microscope. Since there is an average lag period of 2 years between infection and initial sinker formation in both ponderosa and lodgepole pine (Hawksworth and Graham, 1963), 2 years were also added to the annual ring count in this evaluation. Twenty-two infections on 16 "symptomless" trees were aged using this procedure. The study area had been treated in 1980, so any infections 8 years or older were present at the time of initial stand treatment. Eighty percent of the branch infections dissected and aged were between 8 and 11 years old. Many of the other 32 trees correctly diagnosed as infected during the first marking, had probably been infected during stand treatment in 1980.

CONCLUSIONS AND RECOMMENDATIONS

Data from both evaluations indicate that the thinning-sanitation treatment failed to remove all visibly infected trees, even in so-called "lightly" infested stands. Though all visibly infected trees were removed during harvest and following precommercial thinning, visible infections levels soared in sampled timber sale areas 10 years after treatment. The apparent cause of treatment failure was due to the inability to recognize dwarf mistletoe infection at the time of thinning-sanitation. This is because newly infected trees show no external symptoms of the disease for several years due to the long life cycle of the parasite. To complicate matters even further, many infections do not result in the formation of aerial shoots for a considerable length of time. These sites are known as latent infections, and most commonly occur on stressed or suppressed trees, or on trees with several more developed dwarf mistletoe infections. Approximately one-third of all infections are latent in unthinned, infested stands (Knutson and Tinnin, 1980).

Results from this study likely are broadly applicable across dwarf mistletoe infested stands on the Flathead Indian Reservation and elsewhere. Dwarf mistletoe, especially of Douglas-fir, is difficult to identify and selectively harvest from infested stands. Though efforts are commendable, they remain impractical when stand treatments require duplication, only to leave significant numbers of infected, symptomless residuals. Based on the results of the second evaluation, 43 percent of a Douglas-fir stand in the Garden Creek Timber Sale was visibly infested 8 years after thinning-sanitation. After closer inspection, another 29 percent was actually infested, which comprised half of the future residual stand. Hawksworth (1978) reported similar observations in lodgepole pine and developed the "half-again rule" for stands up to approximately 50 percent infested prior to initial sanitation. The rule states that the proportion of infected trees 5 years after the first cut will be about half the original amount.

In the Garden Creek Timber Sale, it is unknown what proportion of the stand was initially removed 8 years ago. In this evaluation, however, 43 percent would have been removed when 72 percent was infested. Leaving such a large percentage of infected trees has negative repercussions for not only healthy neighboring trees, but also for reproduction in the understory. It is recommended that alternatives to the thinning-sanitation procedure be developed for dwarf mistletoe-infested stands on the Flathead Indian Reservation.

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